RECLAMATION

Managing Water in the West

Numeric Simulation Programs and Tools

U.S. Department of the Interior
Bureau of Reclamation

Programs that will be discussed

- Navier-Stokes Equations (CFD): Flow-3d
- St. Venant: SRH-2D (or SRH-W) v1.1
  - Sedimentation and River Hydraulics' Program
  - Was gstars-w
- Surface-Water Management System (SMS)
- AutoCAD
- Topo4 (a program I wrote)

SRH-2D or SRH-W v1.1

- The dynamic wave equations **are the standard St. Venant depth-averaged equations**
- Diffusive Wave Approximation **are further simplification achieved by assuming that the convective and diffusive transports of water are in equilibrium**
- **All flow regimes, i.e., subcritical, transcritical, and supercritical flows, may be simulated simultaneously without the need of a special treatment**
- **Gradually varied flow (assumes minimal vertical acceleration)**

Surface Water Modeling System Model Coupling/Steering (10.0.3)

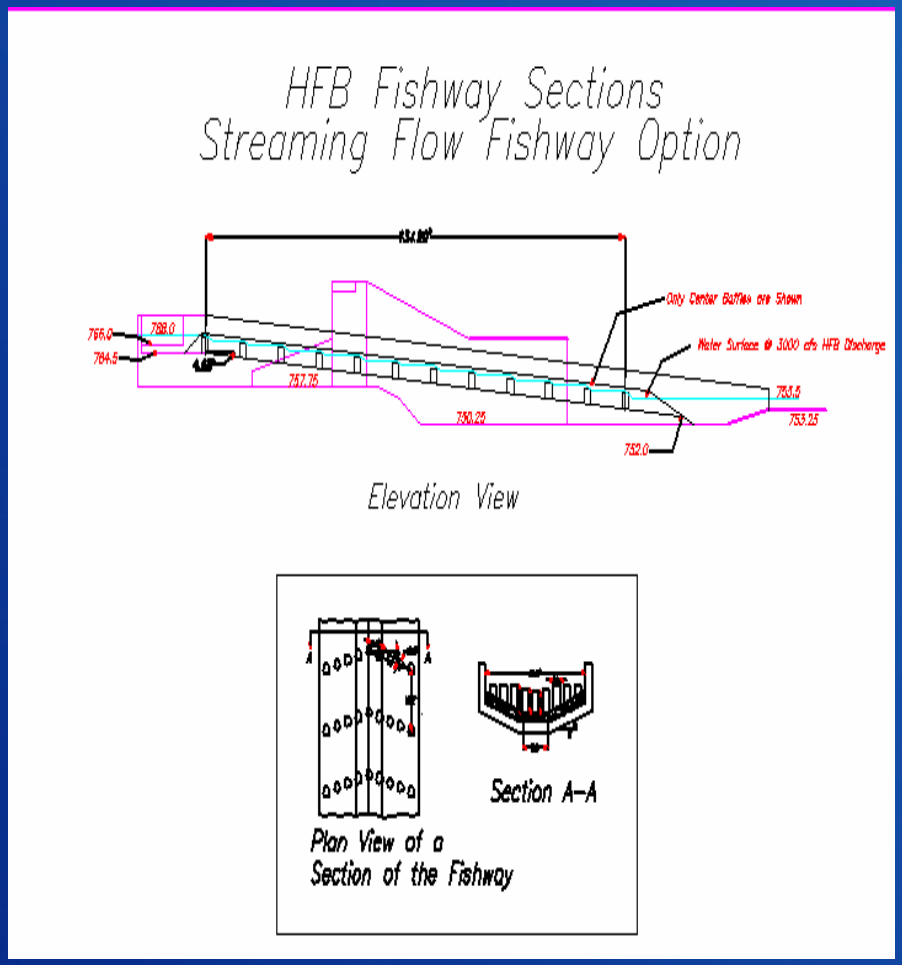
- 2D Mesh generation
- Topography manipulation
- XYZ grid elevation generation

RECLAMATION

Today's Topics

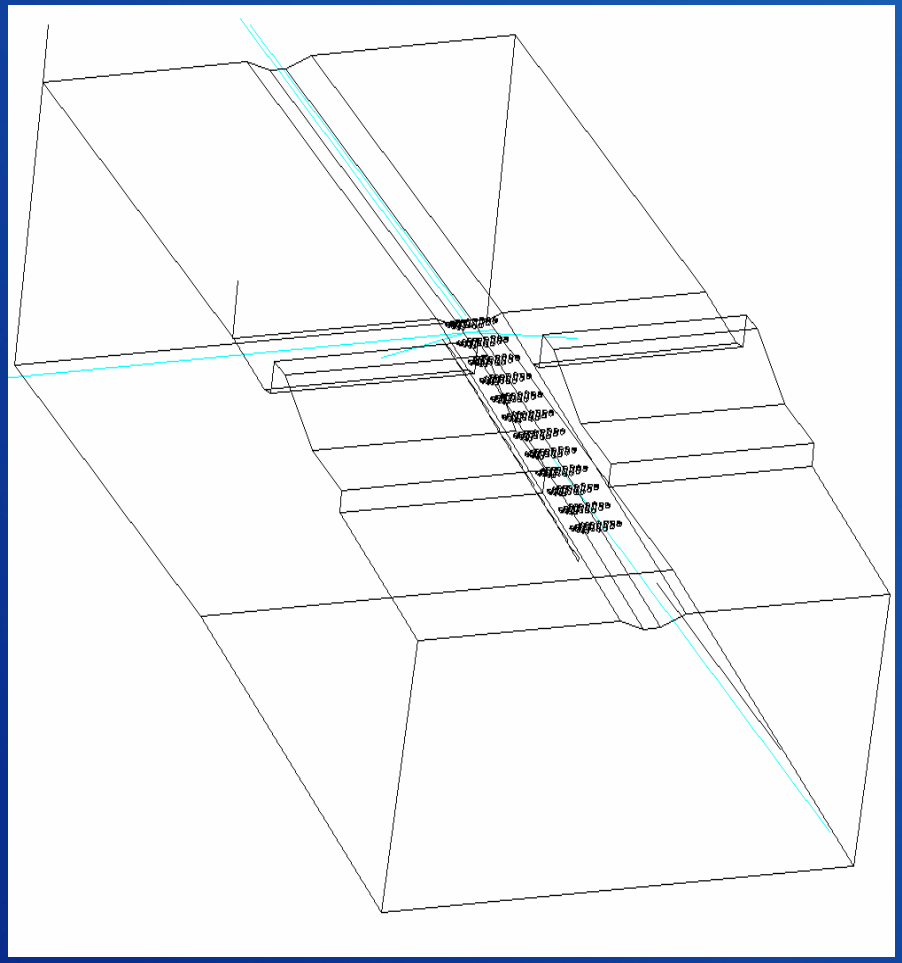
- **Solid objects**
  - **ACAD → *.STL object → Flow-3D**
- **Topography into SMS**
  - **ACAD → *.DWG → SMS**
  - **Scatter XYZ data → SMS**
- SMS into Hydraulics Engine
  - **SMS → *.txt XYZ orthogonal Grid file → Jim's Topo Program → STL object File → Flow-3D**
  - **SMS → *.2dm 2D unstructured Mesh File → SRH-2D**

ACAD ➔ *.STL object ➔ Flow-3D



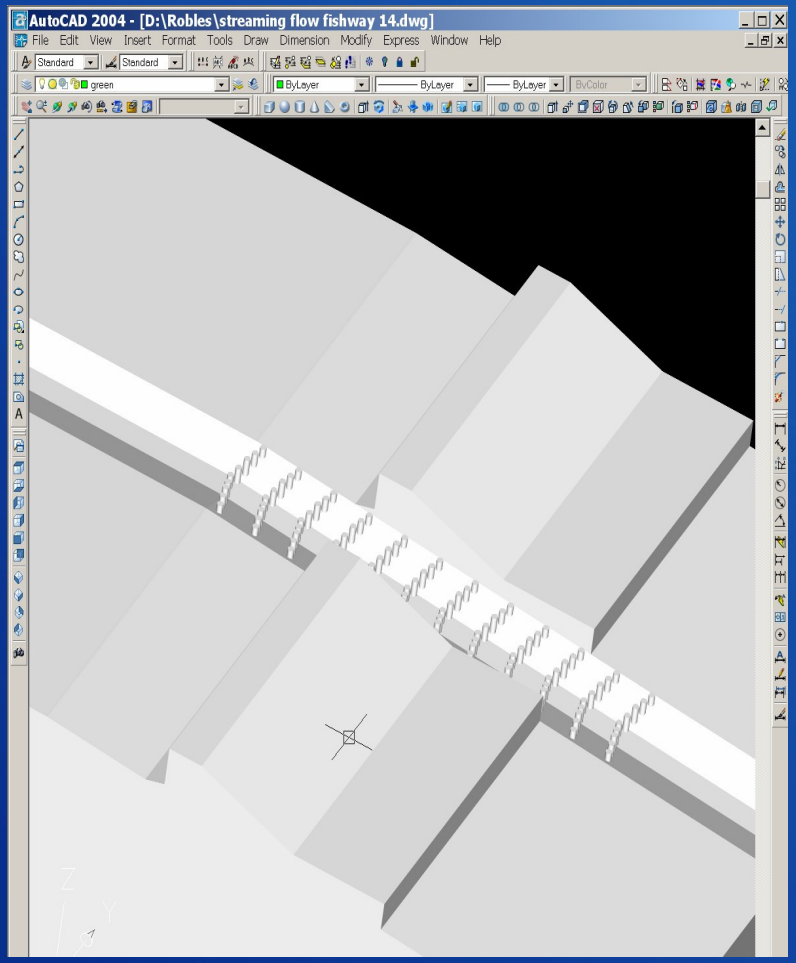
RECLAMATION

ACAD ➔ *.STL object ➔ **Flow-3D**



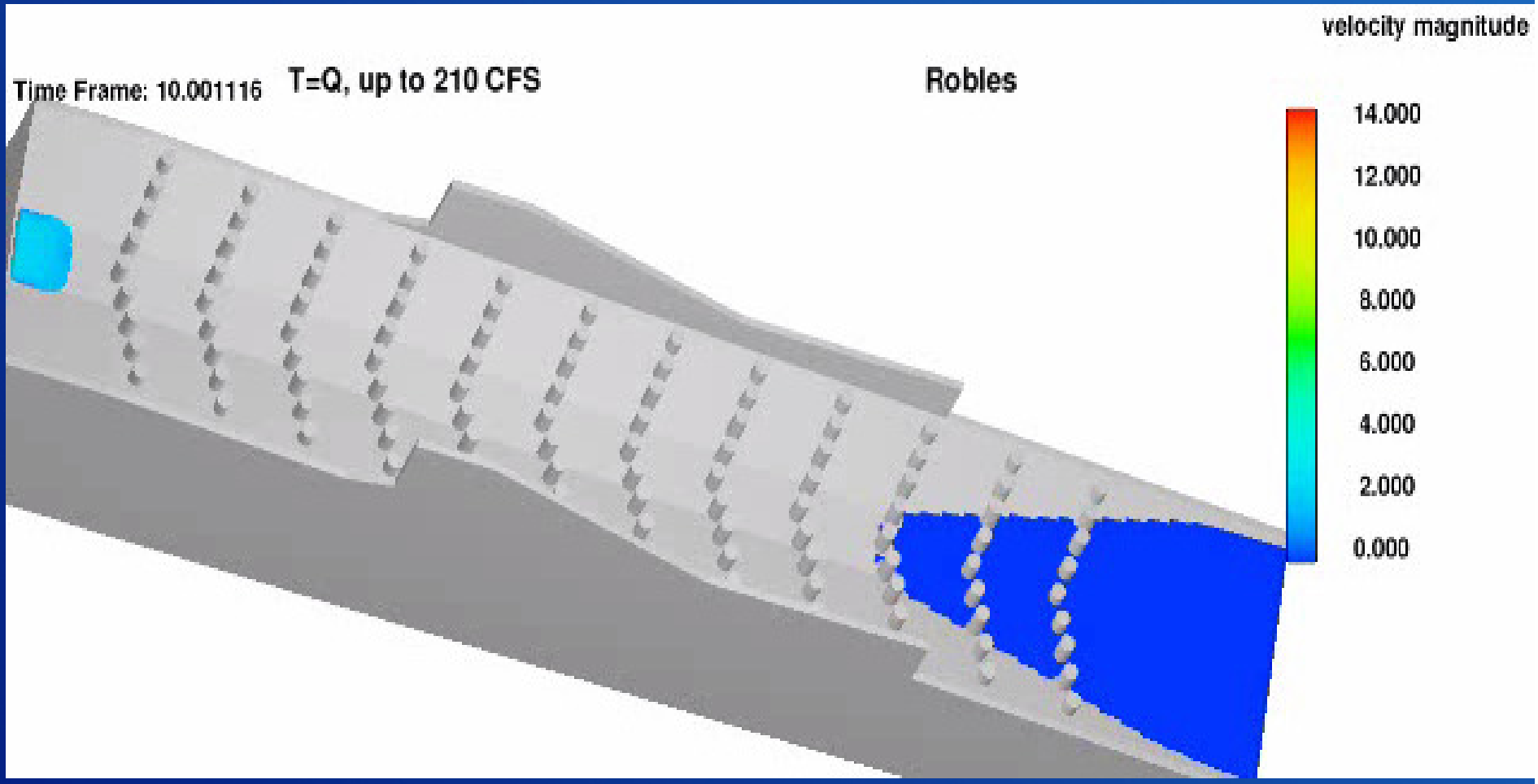
RECLAMATION

ACAD ➔ *.STL object ➔ **Flow-3D**



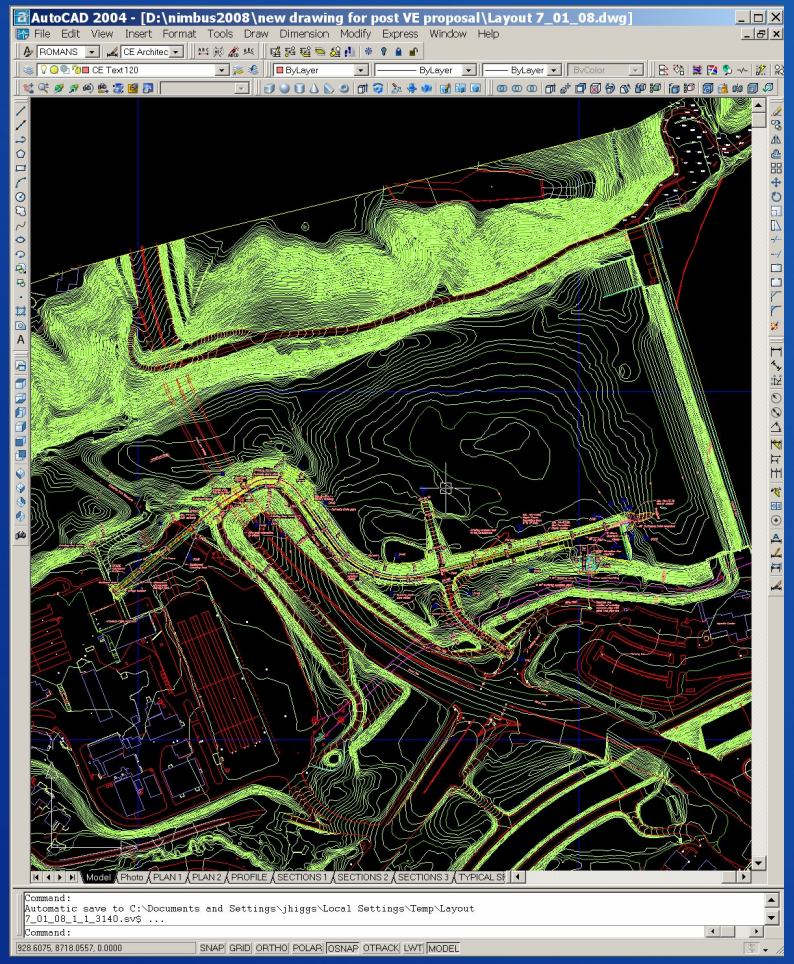
RECLAMATION

ACAD → *.STL object → Flow-3D



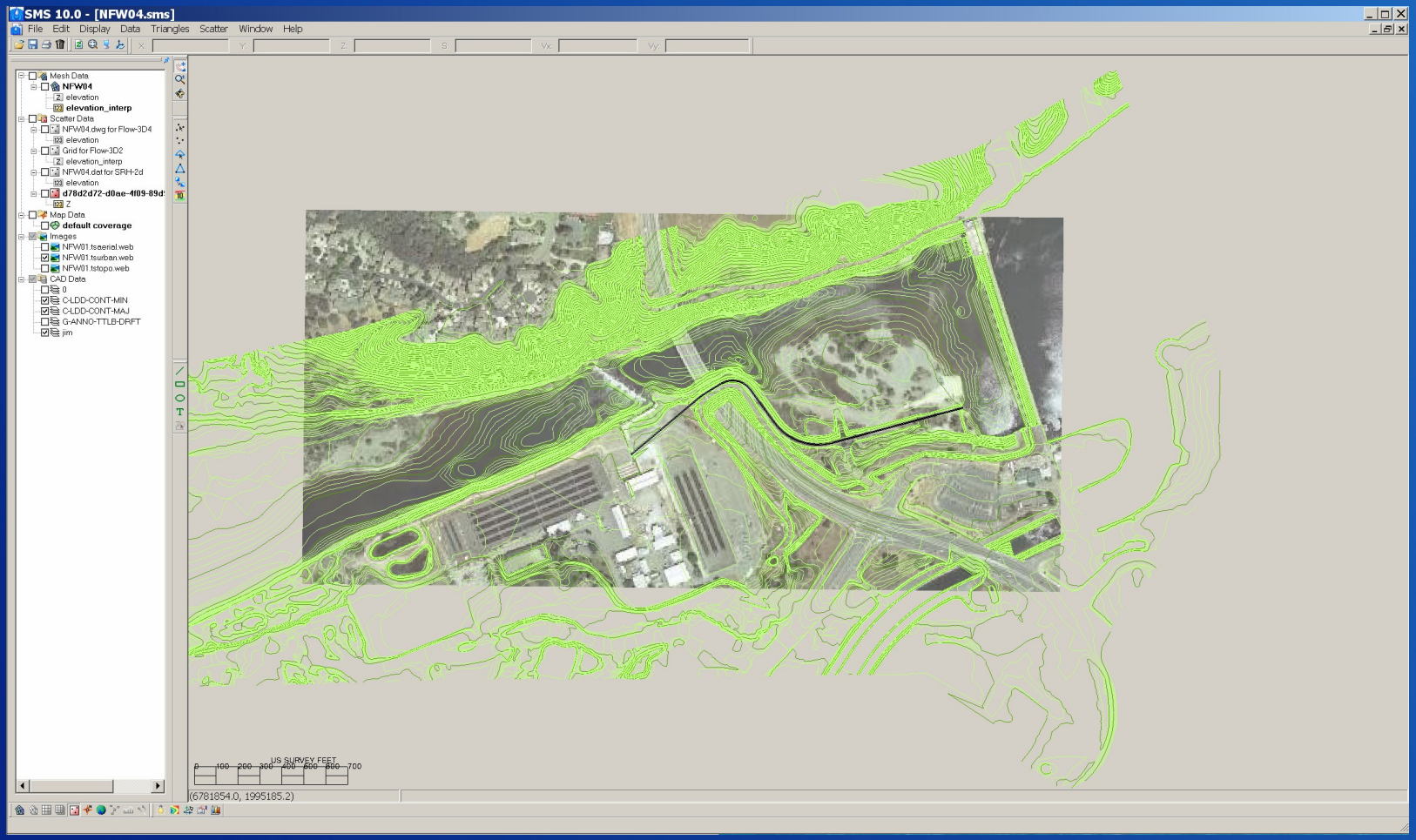
RECLAMATION

ACAD ➔ *.DWG ➔ SMS



RECLAMATION

ACAD ➔ *.DWG ➔ SMS



RECLAMATION

Scatter XYZ data ➔ **SMS**

Microsoft Excel - Final_Nimbus_Bathy.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

Arial 12

G4 sp_north (ft)

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3	**Data from ADMAP**		Transect		ADCP				Adjusted		
4	FID_	Id	Number	EnsNo	Depth(ft)	sp_east (ft)	sp_north (ft)	bed_ele (ft	bed_ele (ft	wse	
5	start	0	1	26	-6.47	6784297.94	1994470.28	75.13	75.46	81.6	
6		0	1	26	-6.9	6784308.61	1994479.91	74.68	75.01	81.58	
7		0	1	26	-6.22	6784298.67	1994479.89	75.39	75.72	81.61	
8		0	1	26	-6.29	6784307.68	1994469.95	75.35	75.68	81.64	
9		0	1	27	-6.37	6784296.11	1994473.55	75.22	75.55	81.59	
10		0	1	27	-7.13	6784306.06	1994484.10	74.44	74.77	81.57	
11		0	1	27	-6.82	6784295.49	1994483.46	74.78	75.11	81.6	
12		0	1	27	-6.55	6784306.02	1994473.67	75.07	75.4	81.62	
13		0	1	28	-6.73	6784293.65	1994476.56	74.86	75.19	81.59	
14		0	1	28	-7.26	6784303.42	1994488.10	74.3	74.63	81.56	
15		0	1	28	-7.09	6784292.58	1994487.01	74.5	74.83	81.59	
16		0	1	28	-7.02	6784304.28	1994477.13	74.59	74.92	81.61	
17		0	1	29	-6.99	6784290.66	1994480.01	74.6	74.93	81.59	
18		0	1	29	-7.08	6784300.37	1994491.75	74.47	74.8	81.55	
19		0	1	29	-6.85	6784289.86	1994490.58	74.73	75.06	81.58	
20		0	1	29	-7.03	6784301.47	1994480.97	74.58	74.91	81.61	
21		0	1	30	-6.85	6784287.79	1994484.01	74.73	75.06	81.58	
22		0	1	30	-6.85	6784297.20	1994495.45	74.69	75.02	81.54	
23		0	1	30	-6.75	6784286.98	1994494.35	74.82	75.15	81.57	
24		0	1	30	-6.81	6784298.30	1994485.04	74.79	75.12	81.6	
25		0	1	31	-6.75	6784284.94	1994487.81	74.81	75.14	81.56	
26		0	1	31	-6.62	6784293.82	1994499.20	74.92	75.25	81.54	
27		0	1	31	-6.66	6784283.90	1994497.99	74.9	75.23	81.56	
28		0	1	31	-6.84	6784295.39	1994488.94	74.74	75.07	81.58	
29		0	1	32	-6.66	6784281.97	1994491.85	74.89	75.22	81.55	
30		0	1	32	-6.52	6784290.55	1994503.14	75.02	75.35	81.54	

Meta Data | Bed Elevation XYZ | US Bed Contours | DS Bed Contours

Draw AutoShapes

Ready NUM

RECLAMATION

Scatter XYZ data ➔ SMS

RECLAMATION

SMS → *.txt XYZ orthogonal Grid file → Jim's Topo Program → STL object File → Flow-3D

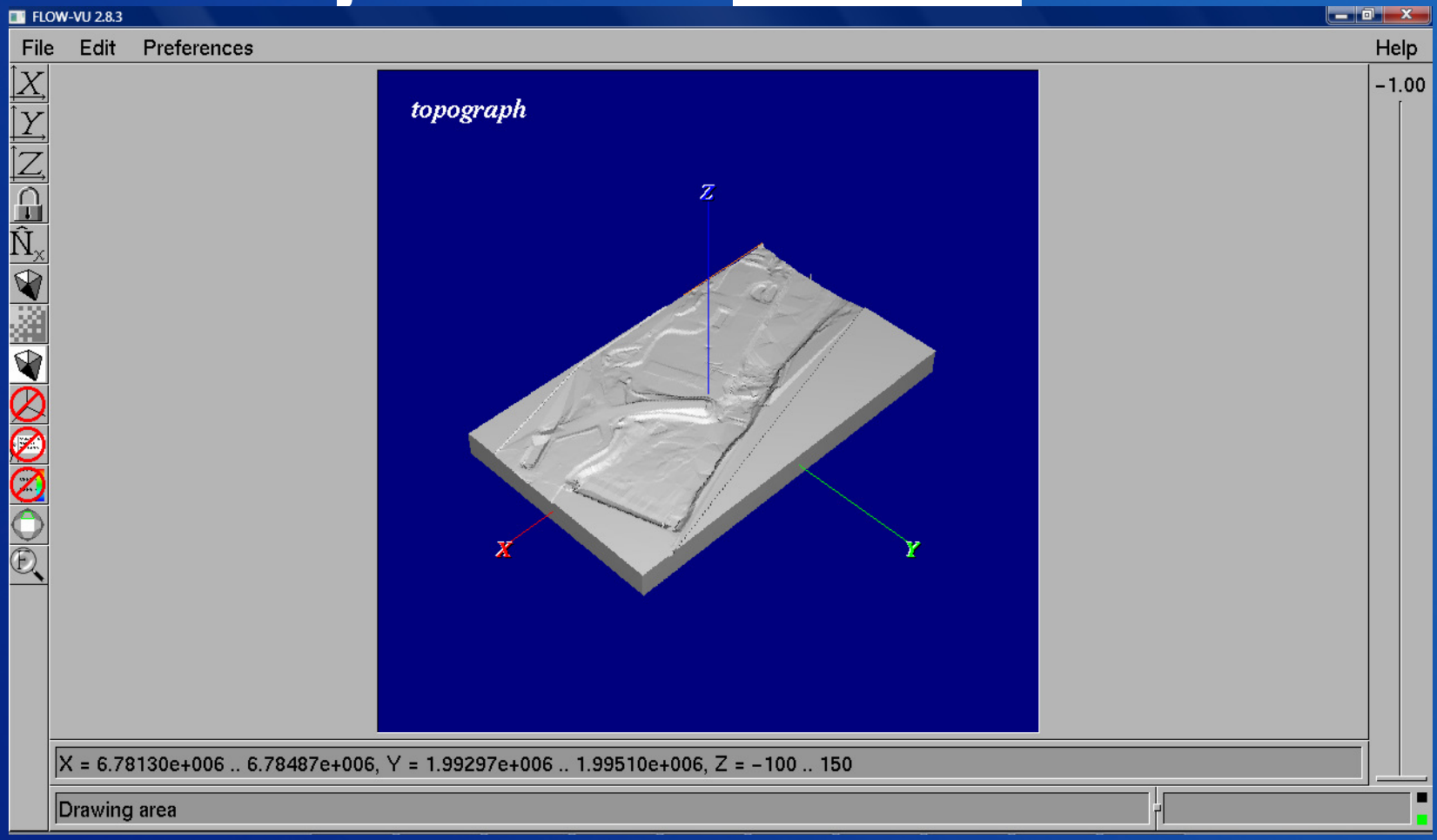
```
print *,"Building X and Y arrays"
open (1,file='shasta50.dat',action='read' )
read (1,*) xi,yi,zi
if (xi.lt.x_min) x_min=xi
if (yi.lt.y_min) y_min=yi
if (zi.lt.z_min) z_min=zi
if (xi.gt.x_max) x_max=xi
if (yi.gt.y_max) y_max=yi
if (zi.gt.z_max) z_max=zi
x(1)=xi
ix=1
y(1)=yi
iy=1
DO WHILE (.NOT. EOF(1))
        read (1,*) xi,yi,zi
        if (xi.lt.x_min) x_min=xi
```

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program ➔ STL object File ➔ Flow-3D

```
solid topograph
  facet normal   0.000E+00   0.000E+00   0.250E+04
    outer loop
       vertex   -0.223E+07  -0.358E+06   0.800E+03
       vertex   -0.223E+07  -0.358E+06   0.800E+03
       vertex   -0.223E+07  -0.358E+06   0.800E+03
    end loop
  end facet
  facet normal   0.000E+00   0.000E+00   0.250E+04
    outer loop
       vertex   -0.223E+07  -0.358E+06   0.800E+03
       vertex   -0.223E+07  -0.358E+06   0.800E+03
       vertex   -0.223E+07  -0.358E+06   0.800E+03
    end loop
  end facet
....
```

RECLAMATION

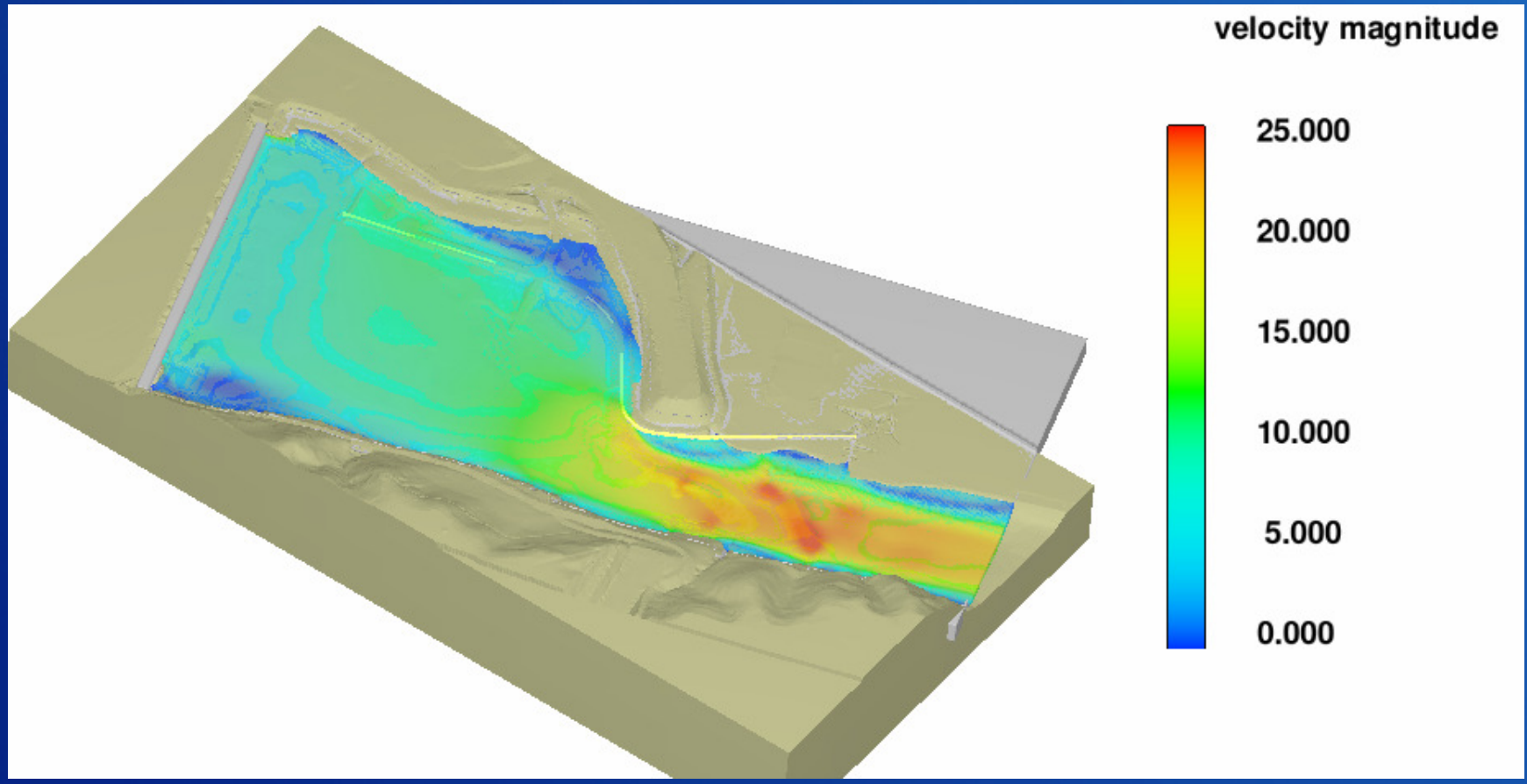
SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program ➔ STL object File ➔ Flow-3D



RECLAMATION

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program

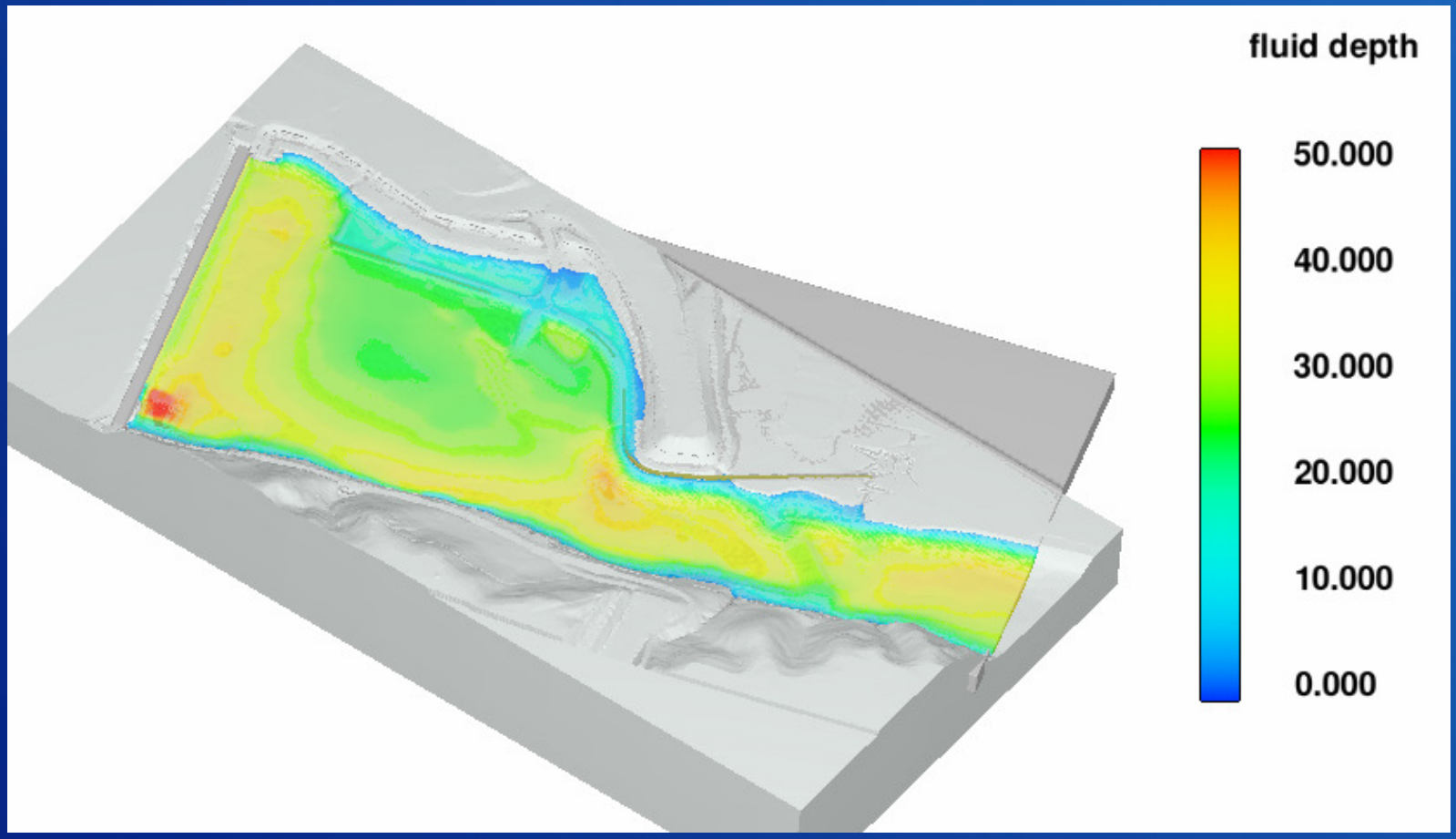
➔ STL object File ➔ **Flow-3D**



RECLAMATION

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program

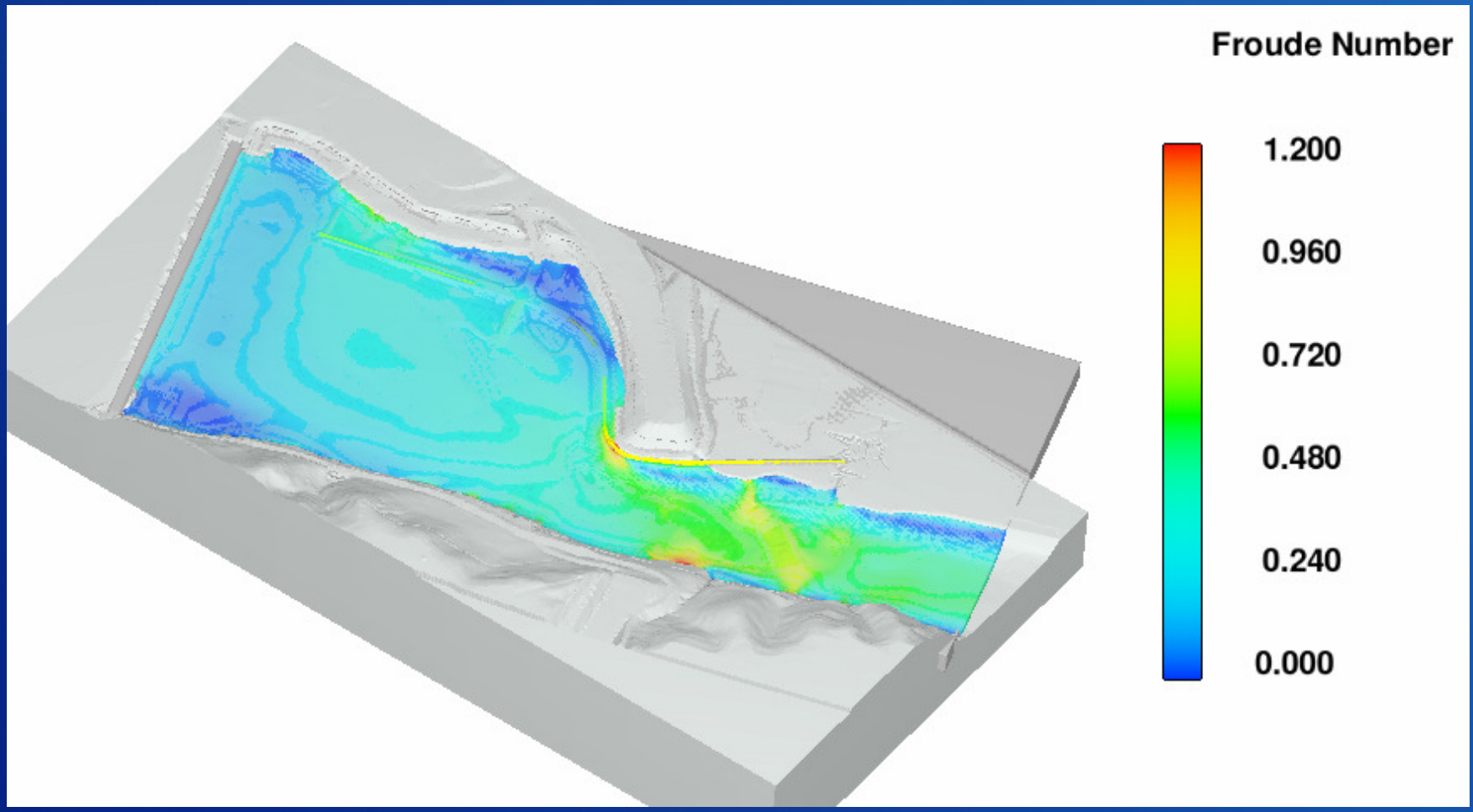
➔ STL object File ➔ **Flow-3D**



RECLAMATION

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program

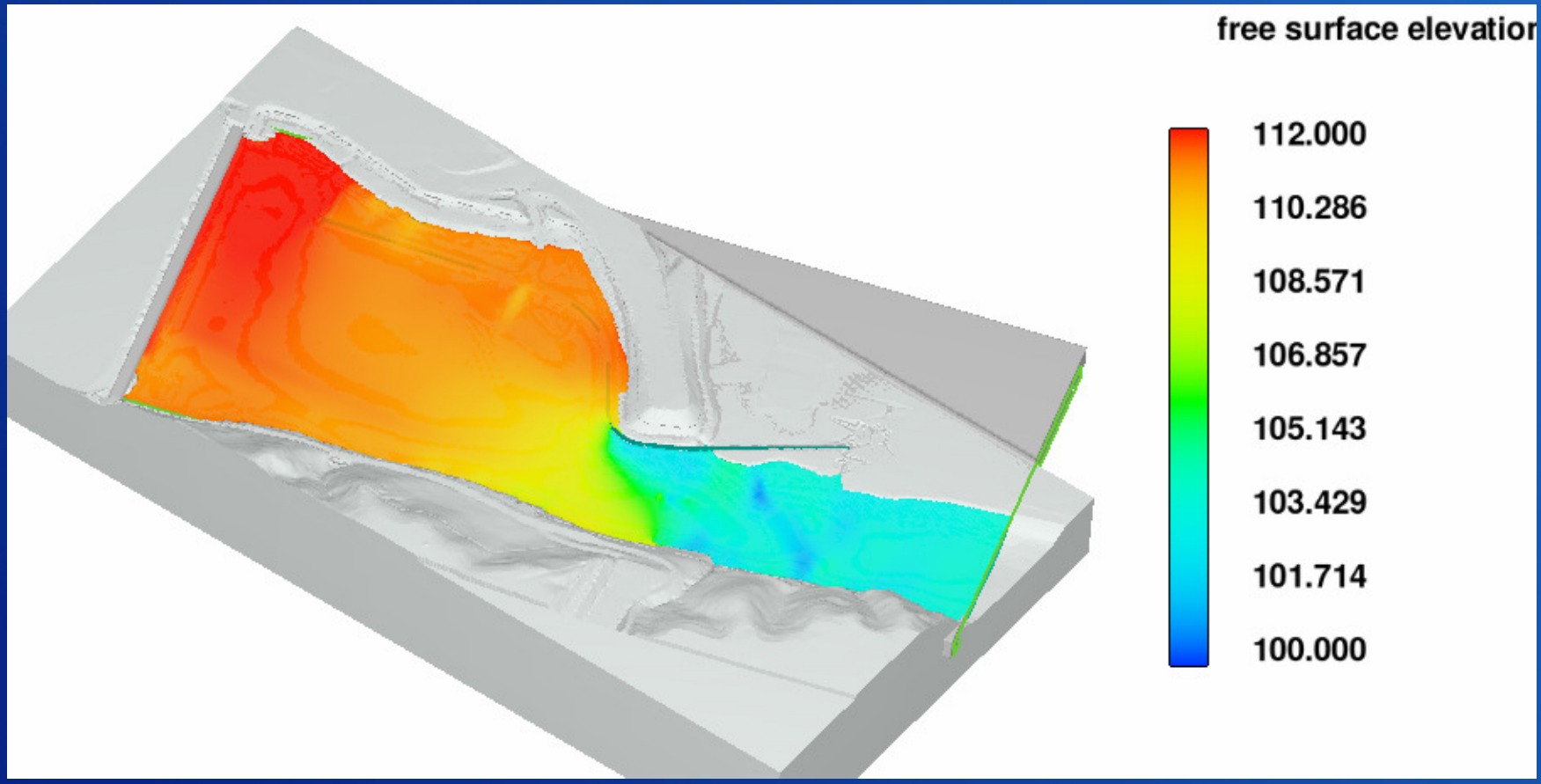
➔ STL object File ➔ **Flow-3D**



RECLAMATION

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program

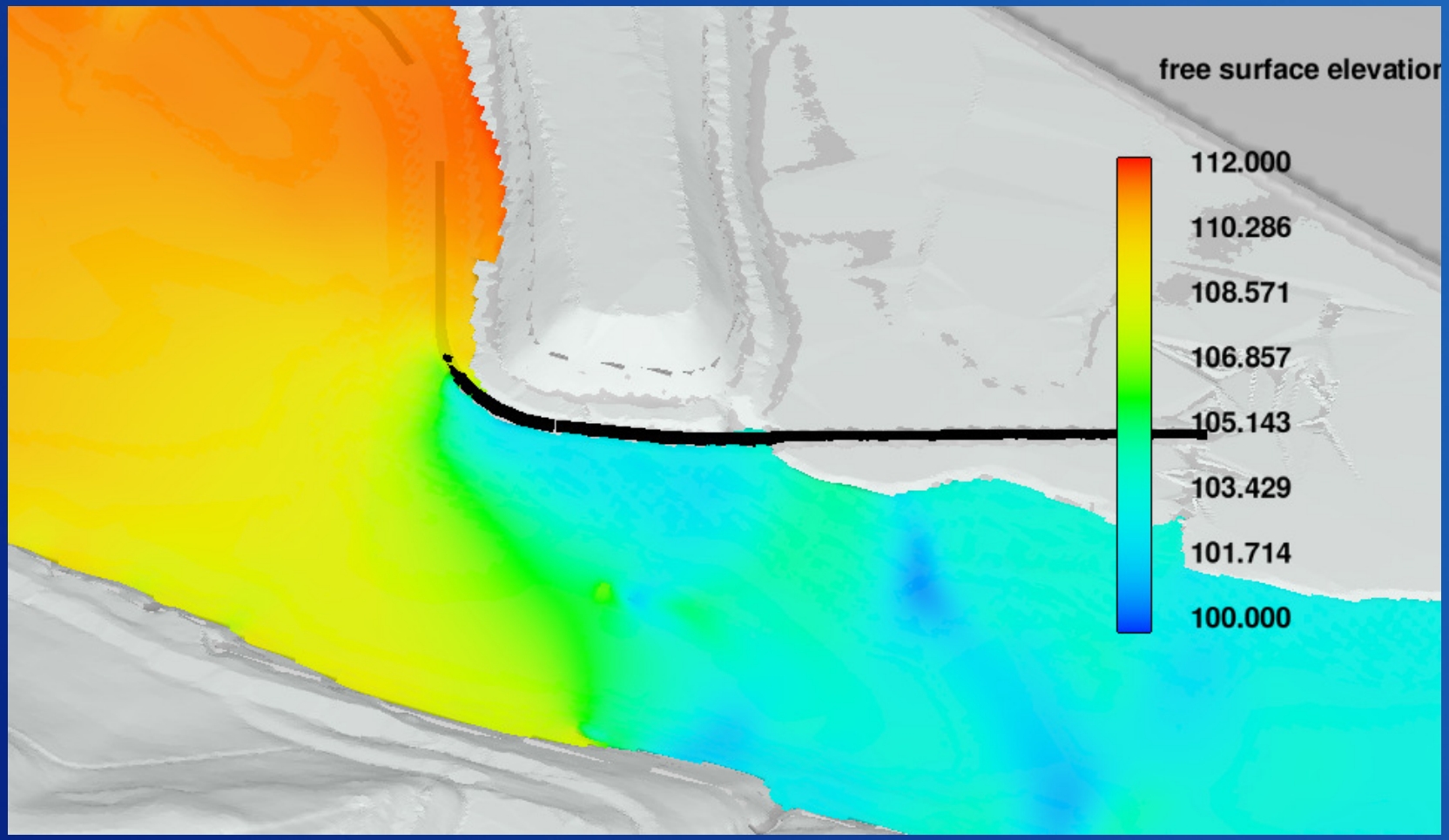
➔ STL object File ➔ **Flow-3D**



RECLAMATION

SMS ➔ *.txt XYZ orthogonal Grid file ➔ Jim's Topo Program

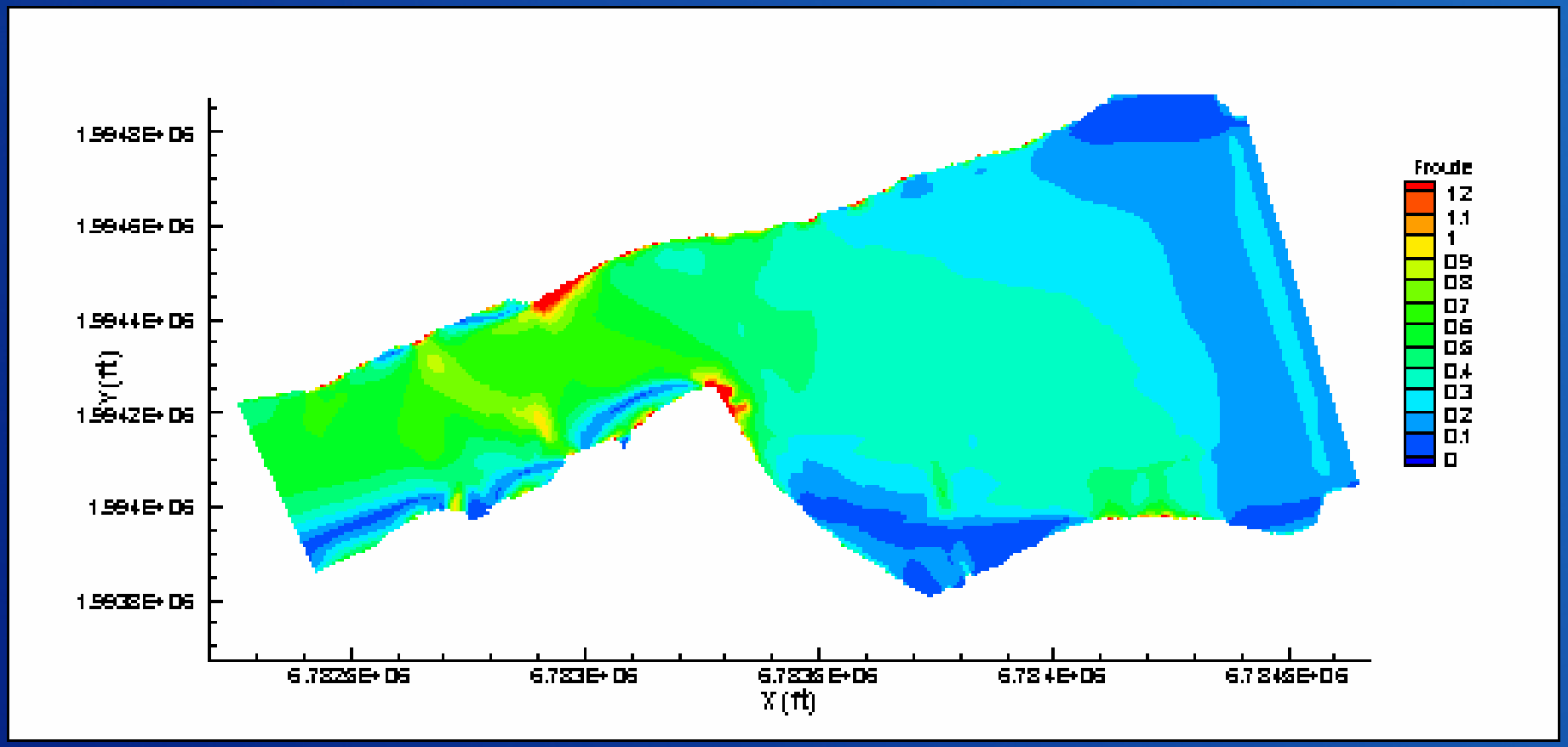
➔ STL object File ➔ **Flow-3D**



RECLAMATION

SMS ➔ *.2dm 2D unstructured Mesh File ➔ SRH-2D

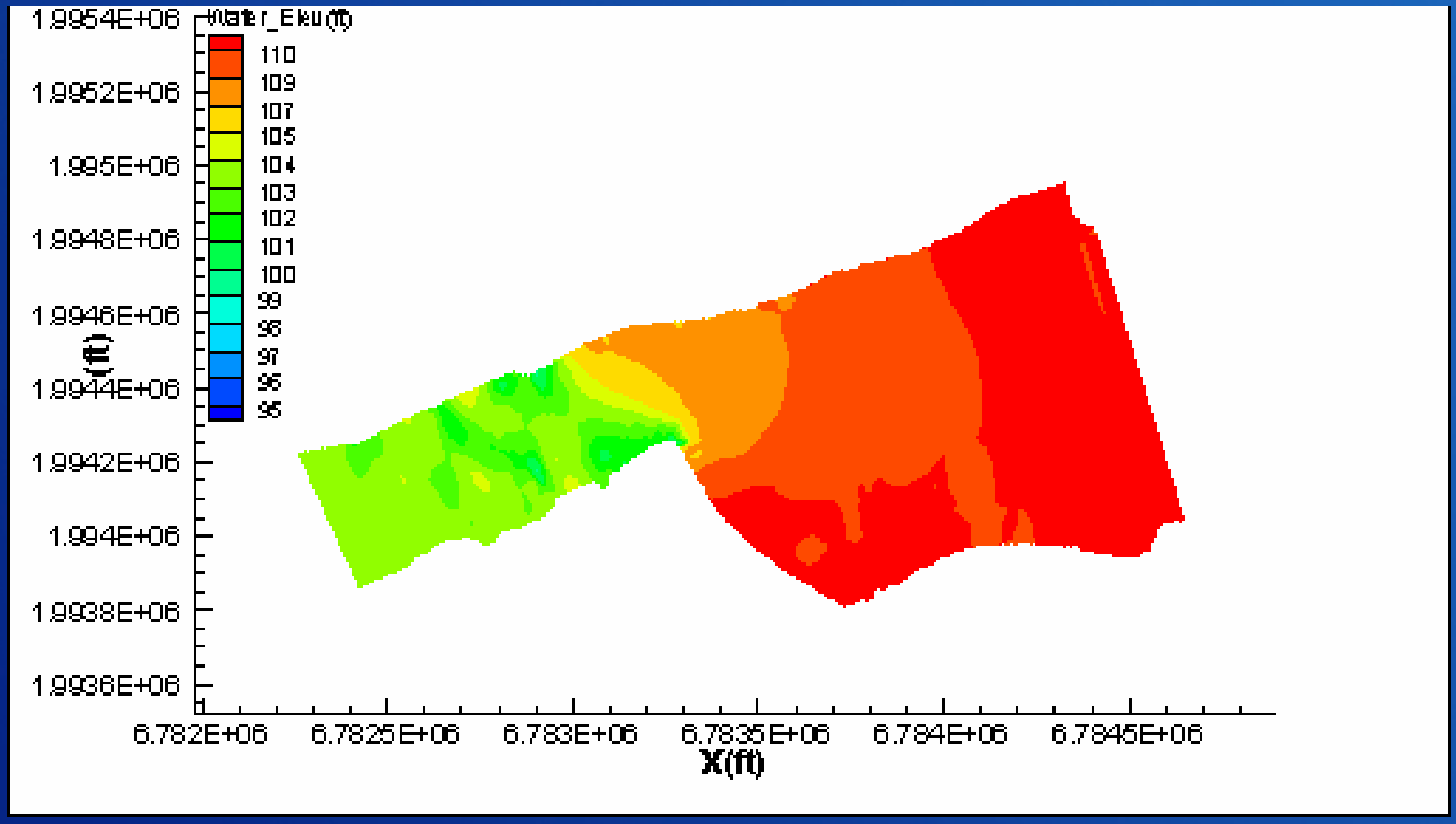
Froude



RECLAMATION

SMS ➔ *.2dm 2D unstructured Mesh File ➔ SRH-2D

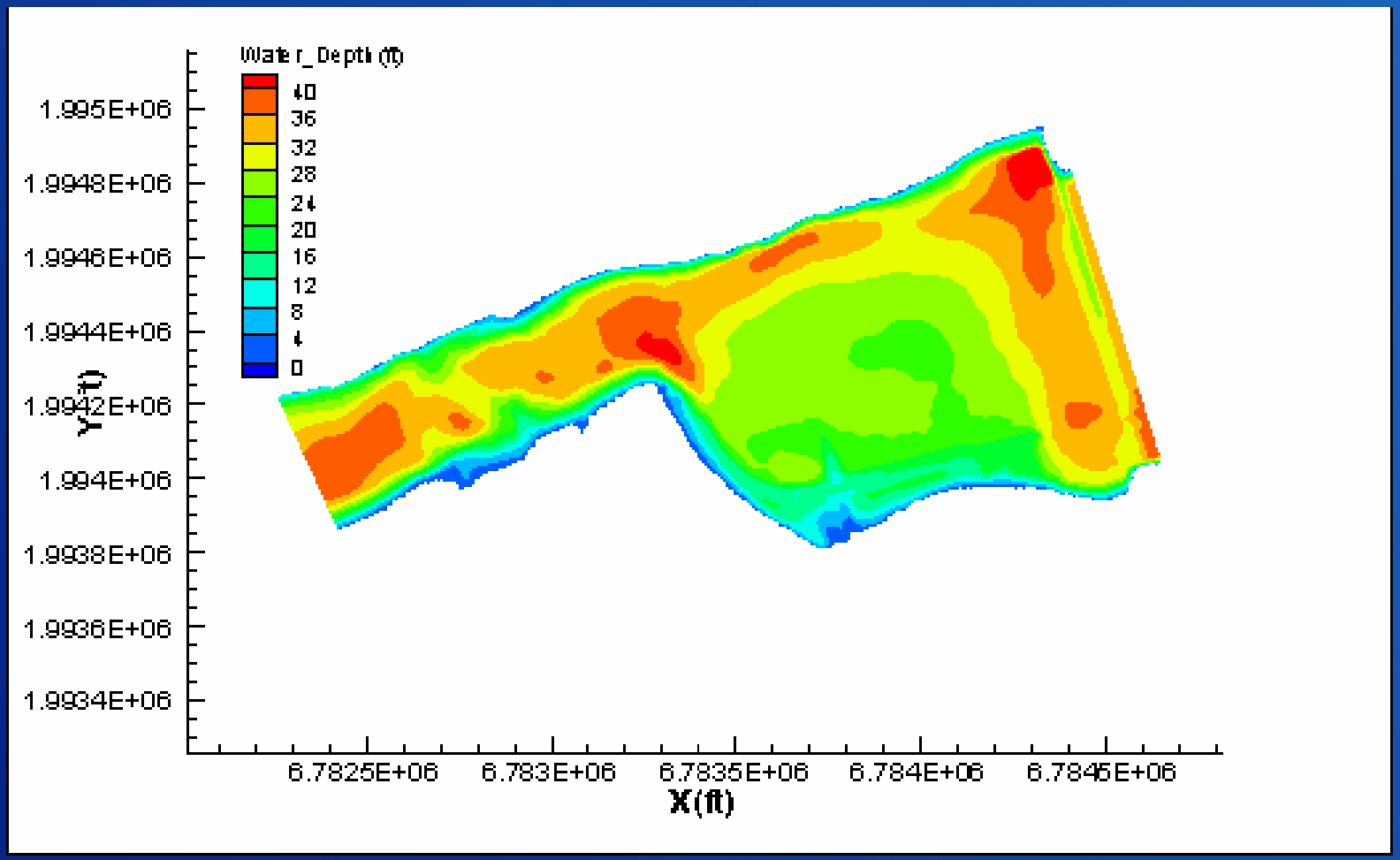
Elevation



RECLAMATION

SMS ➔ *.2dm 2D unstructured Mesh File ➔ SRH-2D

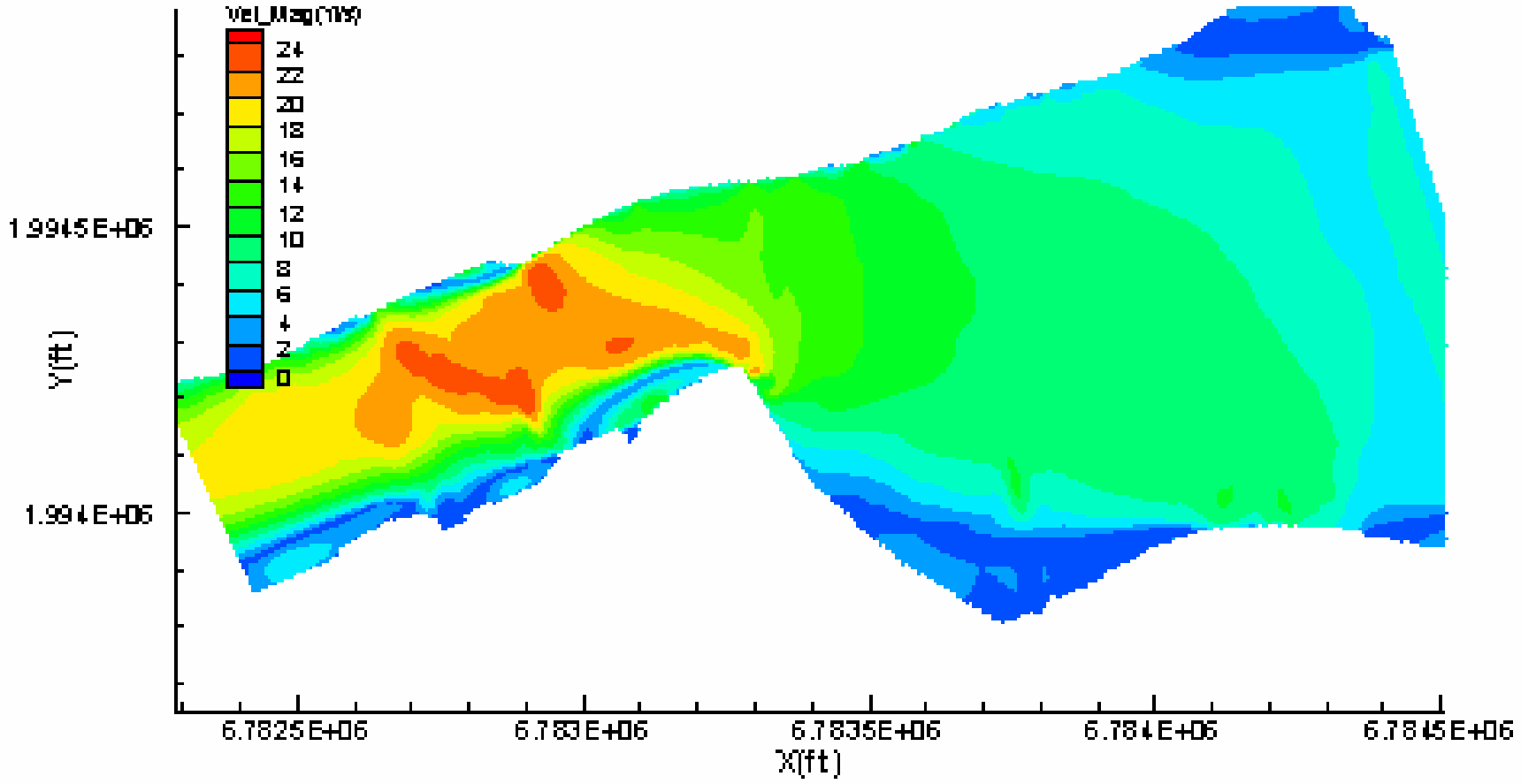
Depth



RECLAMATION

SMS ➔ *.2dm 2D unstructured Mesh File ➔ SRH-2D

Velocity



RECLAMATION

Surface Water Modeling System Model Coupling/Steering

- Many of the tasks performed as part of a numerical simulation are repetitious and time consuming. For example, a single project generally involves running the model many times in a "warm up" or "spin down" mode. To make this type of process easier, a tool referred to as the Steering Module. The main objectives of the Steering Module are to:
- Simplify data sharing between models
- Monitor model runs
- Save time by automating repetitive user tasks
- Achieve more accurate results from models
- The tasks the steering module performs can be classified in two main groups. These include single model control, and multiple model coupling. The control channels currently available in the Steering Module are:
- RMA2 Spin Down
- FESWMS Spin Down
- CMS-Flow<->CMS-Wave Interaction

RECLAMATION

Modules and Model Interfaces

- $650 **Map Module (REQUIRED for all licenses)**
- $750 **Mesh Module**
- $650 **Scatter Point Module**
- $650 **Cartesian Grid Module**
- $750 **RMA2 Interface***
- $250 **RMA4 Interface***
- $750 **FESWMS Interface**
- $6,250 **CGWAVE Interface and Model***
- $5,750 **BOUSS2D Interface and Model****
- $3,250 **ADCIRC Interface and Model***
  $600 **STWAVE Interface****
- $600 **CMS Wave Interface**
- $1,400 **CMS Flow Interface**
- $550 **GENESIS Interface**
- $750 **TUFLOW Interface Only*,****
- $6,750 **TUFLOW Interface and Model*, ****
- $3,000 **TUFLOW Multiple Domains**
- $2,150 **PTM Interface and Model**

RECLAMATION

SMS 10.0 Pricing *of Packages*

- $1,200 Vis Package: **(map+mesh) New package**
  $2,950 RMA Package: **(map+mesh+scatter+RMA2+RMA4)**
  $2,700 FESWMS Package: **(map+mesh+scatter+FESWMS)**
  $3,600 Finite Element Riverine Package: **(map+mesh+scatter+RMA2+RMA4+FESWMS)**
  $9,250 TUFLOW Standard Package: **(map+grid+mesh+scatter+TUFLOW+TUFLOW model)**
  $12,250 TUFLOW Complete Package: **map+grid+mesh+scatter+TUFLOW+TUFLOW model+TUFLOW mult domains)**
  $3,250 TUFLOW Interface-Only Package: **(map+grid+mesh+scatter+TUFLOW)**
  $2,450 STWAVE Package: **(Map+CartesianGrid+Scatter+STWAVE)**
  $3,850 CMS Package: **(map+grid+scatter+CMS Flow+CMS Wave)**
  $8,200 CGWAVE Package: **(map+mesh+scatter+CGWAVE+CGWAVE model)**
  $7,600 BOUSS2D Package: **(map+grid+scatter+BOUSS2D+BOUSS2D model)**
  $5,200 ADCIRC Package: **(map+mesh+scatter+ADCIRC+ADCIRC model)**
  $8,800 COASTAL Package: **(map+mesh+grid+scatter+STWAVE+ CMSFlow+CMSWave+ADCIRC+ADCIRC model+GENESIS)**
  $20,800 COASTAL Pro Package: **(map+mesh+grid+scatter+STWAVE+CMSFlow+CMSWave+GENESIS+ADCIRC+ ADCIRC model+CGWAVE+CGWAVE Model+BOUSS2D+BOUSS2D Model)**

RECLAMATION

Complete SMS Packages Independent Models

- $12,550 SMS 10.0 Complete Standard Package **(All except CGWAVE/BOUSS2D/TUFLOW)**
- $34,300 SMS 10.0 Complete Pro Package **(All modules and interfaces)**
- 7,875 HYDRO AS-2D Model **(Price is in EUROS)***

RECLAMATION